

Electron Tube Division

NEW PRODUCT DATA

EMI IMAGE INTENSIFIER TYPE 9692
(Provisional Specification)General

The 9692 tube is basically similar in construction and operation to the standard 9694 intensifier. The tube differs from the 9694 in that the 1st stage of the tube is provided with a phosphor (zinc silicate - titanium) having a decay period of $5\mu\text{s}$. Pulsed operation of the second stage enables limited information stored on this phosphor (by virtue of its $5\mu\text{s}$ decay period) to be intensified. This method of operation allows time for checking the characteristics of the stored image by some external system before the intensification process is initiated. In this way tube noise is eliminated from the intensified image. Further, where noise is present in the incoming optical signal, noise rejection is possible if differentiation between noise and signal can occur without interfering with the image presented to the tube, so that intensification only occurs when image signals are present on the storage phosphor.

General Information

As 9694. (See EMI catalogue ref. 3851)

Electrical Specification

	<u>Min.</u>	<u>Typical</u>	<u>Max.</u>
Cathode and dark current, as 9694			
Overall voltage for 10^5 gain at 4500\AA (D.C.) kV		30	35
Overall voltage for 10^6 gain at 4500\AA (D.C.) kV		40	45
Centre resolution line pairs/mm.	20	25	

Capacity of 1st stage dynode to all other electrodes - 10 pF.

No. of ion scintillations induced due to pulse operation - $< 1/250$ pulses.*

Maximum pulse rate - $10^5/\text{sec}$.

Pulse voltage required to switch tube - 3.8 kV negative pulse when tube operated with 10 kV equivalent on each stage.

In pulsed operation, demagnification, distortion and signal induced background levels are the same as the 9694 tube operating under D.C. conditions.

Resolution in pulsed operation is dictated by pulse shape. The following example illustrates possible results.

Pulse rise time $0.5\mu\text{s}$. Period $10\mu\text{s}$. Decay time $1.5\mu\text{s}$.

D.C. resolution - 25 line pairs/mm.

Pulsed resolution - 22.5 line pairs/mm.

*Measured with rise time of $0.5\mu\text{s}$.

Notes

These tubes can be operated under D.C. or pulsed conditions.

Where discrimination is required between successive pulse images, displayed on the output of the tube, (such as might be required if each event is to be photographed) the P.11 phosphor used in the last three stages of the tube limits the framing rate possible. Where higher framing rates are required tubes can be supplied with zinc silicate phosphors throughout.

Maximum framing rate for tubes with P.11 phosphor output.

$5 \times 10^2/\text{s}$

Maximum framing rate for tubes with Zn_2SiO_4 throughout.

$2 \times 10^4/\text{s}$

Tubes with zinc silicate phosphors throughout have lower gain and resolution due to limitations of this phosphor, as specified below.

Gain at 4500\AA - Minimum 10^4) Maximum overall potential
Typical 4.10^4) (D.C.) 45 kV.

Resolution - Minimum 15 line pairs/mm.
Typical 20 line pairs/mm.

A full account of typical tube operation, pulse circuitry, and setting up instructions is provided in E.M.I. Document No. S870.

Sapphire U.V. transmitting input windows can be provided for these tubes.

Where high discrimination rates are required tubes can be supplied with P.24 storage phosphors ($1\mu\text{s}$ decay). Tube details are available on application.

S853/2pV69
DS.983/2



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EMI ELECTRONICS LTD

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VALVE DIVISION

EMI 4-STAGE IMAGE INTENSIFIERS TYPES 9692 & 9694

(Preliminary Data)

These are cascade image intensifiers of the phosphor/photocathode sandwich type employing magnetic focusing and all photocathodes are of the tri-alkali SbKNaCs type.

In the type 9692 the first stage incorporates the relatively fast zinc-oxide phosphor (P24) to enable the tube to be switched in $1 \mu\text{sec}$. In subsequent stages the more efficient silver-activated zinc-sulphide (P11) phosphors are employed.

The type 9694 is a high gain low background tube with P11 phosphors throughout for night vision applications etc.

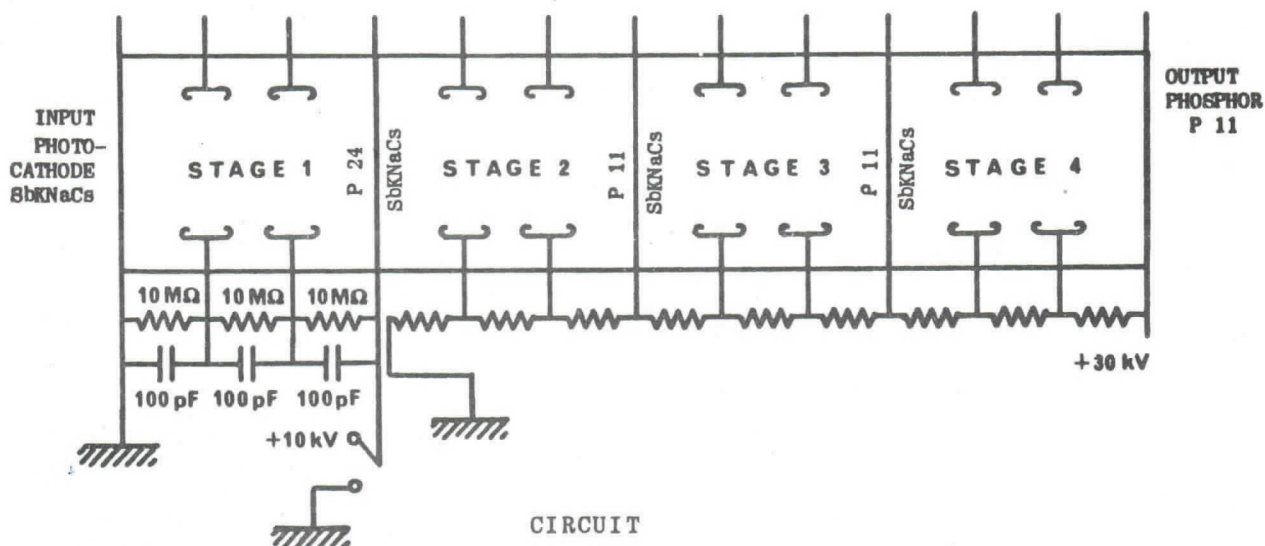
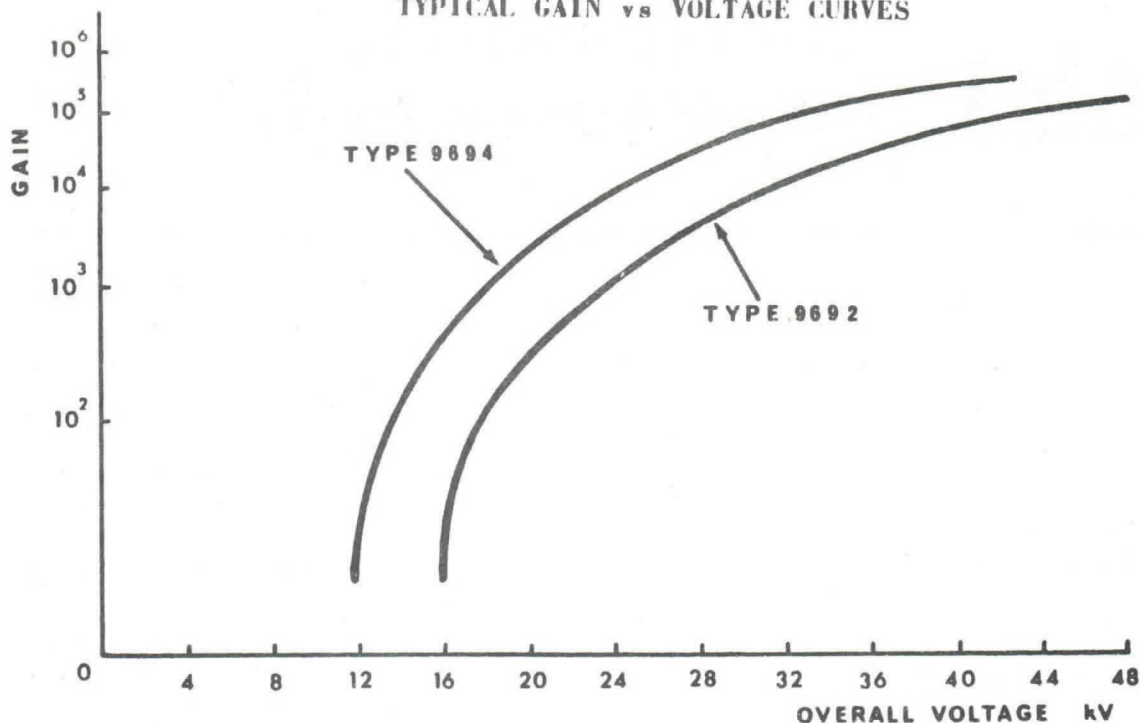
SPECIFICATIONS

Overall length	304.80mm (12 in)
Overall diameter	95.25mm (3.75 in)
Focus coil	13 sections each 25.4mm (1 in) long and 152.4mm (6 in) internal diameter separated by 3.18mm (0.125 in) spacers. Each section consists of 1,200 turns of 22 SWG enamelled copper wire. Field required for single loop focusing 130 to 160 gauss.
End window material	Kodial
Input photocathode	Tri-alkali, 50.8mm (2 in) minimum useful diameter, sensitivity $100 \mu\text{A}/\text{lm}$.
Output phosphor	ZnSAg, useful diameter 50.8mm (2 in) minimum.

	TYPE	9692	9694
Typical light gain at $4,500\text{\AA}$ 35 kV overall		2×10^4	2×10^5
Minimum light gain at 42 kV overall		2×10^5	8×10^5
Maximum overall voltage	kV	45	45
Maximum permissible mean output current	A	10^{-6}	10^{-6}
Electron dark current from photocathode at 42 kV overall	A/cm^2	10^{-16}	10^{-16}
Ion dark current at 42 kV overall	A/cm^2	10^{-17}	10^{-16}
Resolution	line pairs per mm	15 to 18	15 to 18

Water cooled aluminium foil coils are now in the final stages of development which give up to 500 gauss enabling 3 loop focusing which has been found to improve tube geometry and resolution.

TYPICAL GAIN vs VOLTAGE CURVES



Switching carried out by applying voltages as shown. Prior to event stages 1, 3 and 4 are on but stage 2 is off. When event arrives stage 1 is switched off and stage 2 on using hard valve circuitry by applying a negative pulse of 10kV to the first phosphor. The decay time of the phosphor is 1 μ sec. and providing the switching pulse is much shorter, say 100 n. secs., the event will be further intensified by the last three stages sufficiently to enable photography of single electrons leaving the input photocathode. This is achieved by leaving the shutter of the camera open during the non-operative time.

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1510/2c
DS. 388/2



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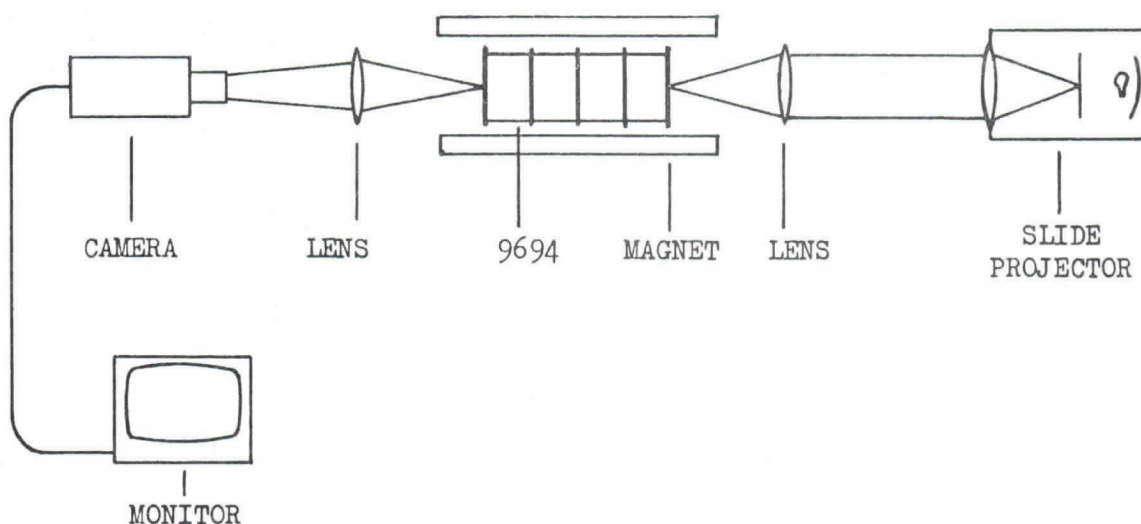
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DEMONSTRATION OF EMI IMAGE INTENSIFIER TYPE 9694

This demonstration uses the EMI 4 stage image intensifier type 9694 coupled to an EMI type 9 closed circuit television system. A standard 35 mm slide projector run at low voltage is used to project a series of slides on to the input photocathode of the image intensifier at a peak white intensity of about 10^{-4} foot candles. This input image is amplified by the tube gain of 10^5 to give an output phosphor brightness of 10 foot candles which is viewed by the vidicon camera.

The type 9694 image intensifier can be run in a permanent focusing magnet as in this demonstration but when it is required to vary the intensifier gain over a wide range a focusing solenoid is employed. The intensifier maximum gain is in excess of 10^6 and the input photocathode and output phosphor are 2 inches in diameter. The centre resolution is in excess of 20 line pairs per millimeter.



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